

Dynamic Flight Simulation Utilizing High Fidelity CFD-Based Nonlinear Reduced Order Model, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)



ABSTRACT

The overall technical objective of the Phase I effort is to develop a nonlinear aeroelastic solver utilizing the FUN3D generated nonlinear aerodynamic Reduced Order Model (ROM). Two types of aerodynamic reduced order models will be developed; the first is the Neural Network nonlinear ROM that can provide the aerodynamic feedback forces due to structural deformation and the second is a nonlinear Volterra-kernels-based gust ROM that provides the aerodynamic forces due to gust excitation. Once developed, this nonlinear aeroelastic solver will be integrated into the Nonlinear Dynamic Flight Simulation (NL-DFS) system in Phase II to perform flight dynamic simulation including nonlinear aeroelastic and nonlinear rigid body interaction effects, which can be used to predict the gust loads, ride quality, flight dynamic stability, and aero-structural control issues. In addition, the nonlinear aeroelastic solver developed can be a standalone code for rapid static/dynamic aeroelastic analysis. With the utilization of the FUN3D generated nonlinear aerodynamic (ROM), this nonlinear aeroelastic solver will be computational efficient for accurate flutter analysis, gust loads analysis and limit cycle oscillation analysis.

ANTICIPATED BENEFITS

To NASA funded missions:

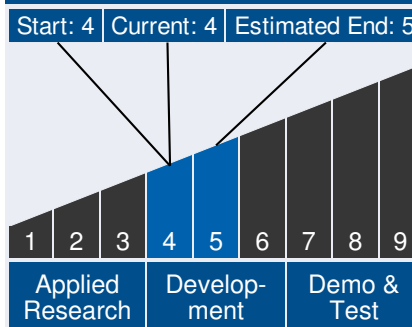
Potential NASA Commercial Applications: A flight dynamics simulation capability with an added nonlinear aeroelastic solver is still unavailable. NASA has been working for many years towards achieving a software package that would accurately predict the interaction between flight dynamics considering airframe structural flexibility in closed-loop with flight control laws. The proposed NL-DFS is aimed at providing an expedient multidisciplinary nonlinear flight simulation tool to perform an efficient flaw debugging for advanced control laws as well as to promote a physical understanding of the in-flight observed dynamic behaviors due to evolutionary designs. It also will assist



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Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

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in the prediction of the instabilities onset prior to envelop expansion programs. NL-DFS will be especially valuable during NASA's current and next generation flying quantities and envelope expansion programs.

To the commercial space industry:

Potential Non-NASA Commercial Applications: The capabilities developed in NL-DFS will strengthen ZONA's market position in the aerospace industry. NL-DFS will be marketed towards flight test applications on a wide class of aerospace vehicles such as: (a) USAF's F-22 and F-35 aircrafts at Edwards AFB; (b) UASF's long range supersonic strike bomber as well as stealth UAV/UCAV; (c) DARPA's advanced design concept; (d) Boeing 787; and (e) future executive jet designs of Cessna, Raytheon, etc. The proposed NL-DFS can also be applied to validate health management strategies specifically designed for aircraft designs with prominent aeroelastic characteristics.

Management Team (cont.)

Principal Investigator:

- Zhicun Wang

Technology Areas

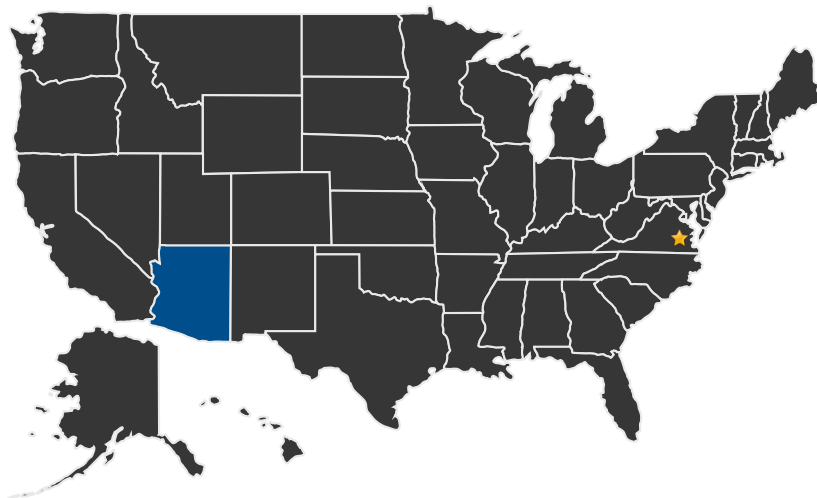
Primary Technology Area:

Modeling, Simulation, Information Technology and Processing (TA 11)

└ Modeling (TA 11.2)

└ Frameworks, Languages, Tools, and Standards (TA 11.2.5)

U.S. WORK LOCATIONS AND KEY PARTNERS



■ U.S. States
With Work

★ Lead Center:
Langley Research Center

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Other Organizations Performing Work:

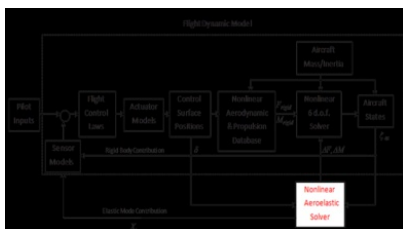
- ZONA Technology, Inc. (Scottsdale, AZ)

PROJECT LIBRARY

Presentations

- Briefing Chart
 - (<http://techport.nasa.gov:80/file/23397>)

IMAGE GALLERY



*Dynamic Flight Simulation Utilizing
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DETAILS FOR TECHNOLOGY 1

Technology Title

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Potential Applications

A flight dynamics simulation capability with an added nonlinear aeroelastic solver is still unavailable. NASA has been working for many years towards achieving a software package that would accurately predict the interaction between flight dynamics considering airframe structural flexibility in closed-loop with flight control laws. The proposed NL-DFS is aimed at providing an expedient multidisciplinary nonlinear flight simulation tool to perform an efficient flaw debugging for advanced control laws as well as to promote a physical understanding of the in-flight observed dynamic behaviors due to evolutionary designs. It also will assist in the prediction of the instabilities onset prior to envelop expansion programs. NL-DFS will be especially valuable during NASA's current and next generation flying quantities and envelope expansion programs.